



MORPHOLOGICAL FEATURES OF THE SMALL INTESTINE IN THE ADULT INDIGENOUS GAZELLE (*Gazella Subgutturosa*)

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ABSTRACT

We dissected and described the macroscopic anatomy of the small intestine of the adult indigenous gazelle (*Gazella Subgutturosa*). A total findings of our study revealed that the small intestine was composed of three segments that named; duodenum, jejunum and ileum with no unmistakable anatomical demarcation line seem isolated between them. It situated in the most right caudal area of abdominal cavity which starting from the stomach and ended at the caecum. The mesentery was permits an extraordinary level of mobility to the small intestine, the entry of blood vessels and nerves and maintained the fixation of the small intestine with the midline of the body. The ratio of small intestine to the body length was appearing about 9 times.

KEYWORDS: Morphology, gazelle, small intestine, measurement.

INTRODUCTION

The goitered or black-tailed gazelle (*Gazella subgutturosa*) was a widespread species, free living in northern Azerbaijan, eastern Georgia Iran, Iraq, southwestern Pakistan, southeastern Turkey, Afghanistan and the Gobi Desert (Amos, 2011, Murtskhvaladze *et al.*, 2012). The ruminants were assorted to three groups depending on their feeding type into browsers, intermediate feeders and grazers (Hofmann, 1989). The gazelle eats a wide assortment of plant species (Murtskhvaladze *et al.*, 2012). The digestive tract is an essential system in living organisms, as it plays a fundamental role in the food processing and absorption (Hill *et al.*, 2008). Hofmann (1989) reported that there were morphological differences in the small intestine and these will lead to consequent physiological differences. The position of small intestine in the abdominal cavity and its mesentery attachment lead to the essential function of small intestine such as digestion and storage of food and eventually expulsion of feces (Hildebrand & Goslow, 2006). On other hand, the small intestine nourished by the celiaco-mesentric trunk, which assist to supply the small intestine with the necessary oxygen and glucose (Bruni & Zimmerl, 1947, Nickel & Schummer, 1977). According to our knowledge, there was no data on the anatomical observation in the goitered gazelle has been recorded previously. Thus, this study aimed to investigate this topic and to dissect and described the anatomical characteristics of the small intestine of six goitered gazelle that recorded in other domestic ruminant especially the mesenteric structure, as well as to compare anatomical measurements with other wild ruminant species.

MATERIALS & METHODS

A total of 6 animals were collected from a free-living gazelle's population located in the protected (Ksebah), at Madain Township/Baghdad for morphological

observation. The mean body weight of the animals was 16.60 ±0.51 kg. The animals were slaughtering to remove the abdominal wall ventrally, then the small intestine separated away by sectioned from the pyloric area of abomasum cranially in side and the cecum caudally in another side, as well as it was isolated from the close attachments to the dorsal abdominal wall. Small intestine contents were measured including the weight, length of each segment of small intestine (duodenum, jejunum and ileum) by sensitive balance and measuring tape (Hofmann, 1969). As well as the relative weight and length of the duodenum, jejunum, ileum to the total small intestine weight was measured (Adeola and King, 2014). Moreover, the dimensions of the duodenum, jejunum and ileum were measured by vernier caliper after emptying its contents. The anatomical observations were photographed by using a digital camera (Nikon D7000; Nikon Corporation, Tokyo, Japan). The above processing was used according to the Nomina Anatomica Veterinaria (2012). The results are presented as mean ±SD.

RESULTS

Shape, position and attachment

The small intestine of the indigenous Gazelle was situated in the most right caudal area of abdominal cavity which starting from the stomach and ended at the caecum. It was consist of three segments that named; duodenum, jejunum and ileum with no unmistakable anatomical demarcation line seems isolated between them (Fig. 1, 2 & 3). These results were compatible with the results obtained by some researchers (Barone, 1997, Smith, 1984, Klaus-Dieter and Robert, 2003) in bovines, ovines and caprine, as well as (Perez *et al.*, 2008, Perez *et al.*, 2009, Pérez, and Vazquez, 2012, and Perez, *et al.*, 2014) in pampas deer, giraffe, brown brocket deer and Free-living axis deer respectively, who mentioned that the greater part of the whole intestine

Features of the small intestine in the adult indigenous gazelle

was situated within the supraomentalis recess at the right side and extend caudally to left side of abdominal cavity.

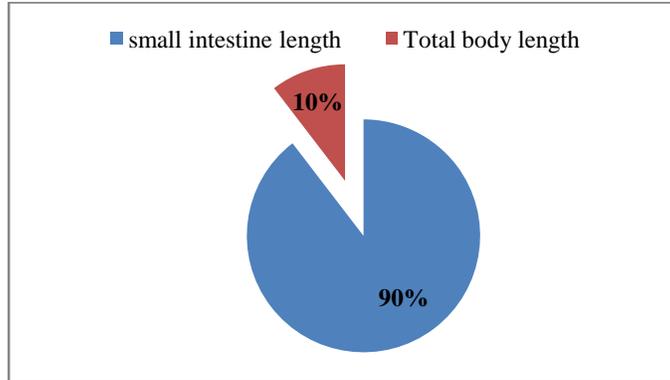


FIGURE 1: Show the animal length, the intestine length and the ratio of animal length to small intestine length (cm). The numbers represent the mean \pm standard error.

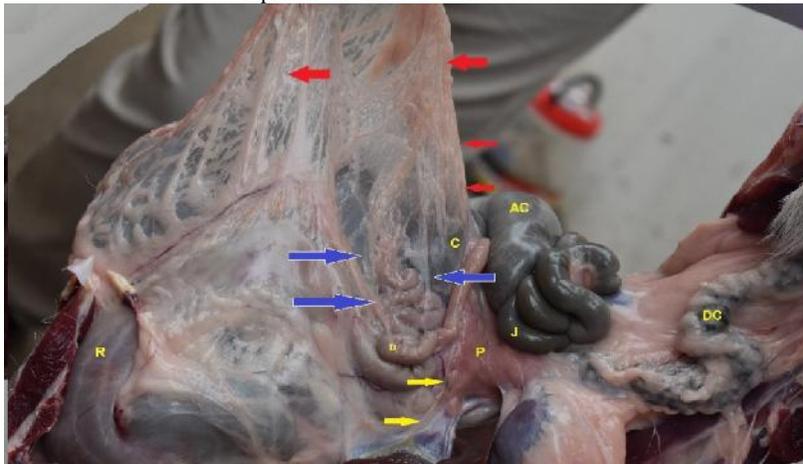


FIGURE 2: Photograph shows dissected digestive tract in situ the indigenous Gazelle. It showed abomasum (AB), ascending colon (AC), cecum (C), duodenum (D), descending colon (DC), gall bladder (gb), jejunum (J), liver (L), Rumen (R), greater omentum and mesogastrium (red arrow), mesoduodenum (blue arrow) and common bile duct (yellow arrow). The duodenum includes pancreas between its limbs (P).

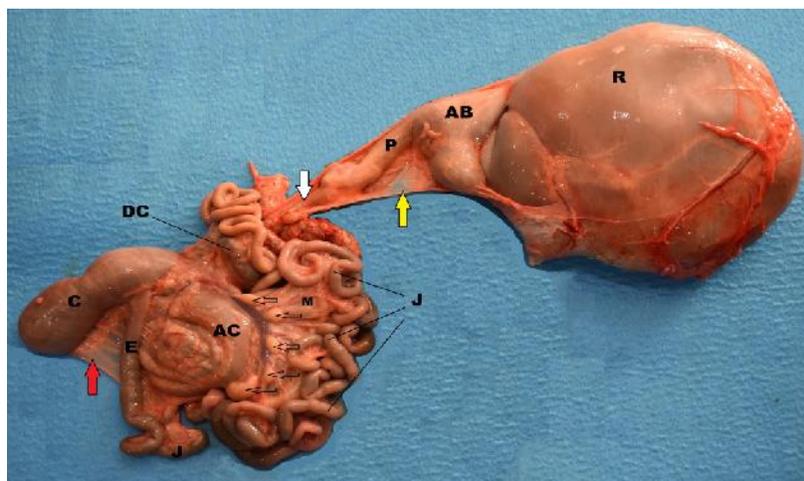


FIGURE 3: Photograph shows different parts of small and large intestine of the indigenous Gazelle. It showed: Abomasum (AB), ascending colon (AC), cecum (C), descending colon (DC), ileum (E), jejunum (J), mesojejunum (M), pyloric part of abomasum (P), rumen (R), part of lesser omentum – gastrohepatic ligament or lesser omentum (yellow arrow), duodenum (white arrow), ileocecal fold (red arrow) and jejunal lymph nodes (black arrow).

Anatomically, the finding exposed that the small intestine was associated with the dorsal abdominal wall by the dorsal mesentery over its whole length. The mesentery was generally long for the most part and permits an

extraordinary level of mobility to the small intestine, permitting the entry of blood vessels and nerves and fix the small intestine in position to prevent it from the midline of the body (Fig. 2, 3 and 4). The result above was similar to the finding of many authors (Klaus-Dieter and Robert, 2003) in bovine who reported that the mesentery is attached an envelope in the small intestine was also combined with the intestinal mass to form a common mesentery. While Perez *et al.*, (2008) in pampas deer, stated that the majority of intestine was included within the supraomentalis recess and in another aspect the adherence of the spiral part of the ascending colon to the

left sheet of the mesenterium lead to limitation to the mobility of jejunum.

A superficial wall of greater omentum was appended the descending duodenum dorsally on the right side, while profound wall of greater omentum adhere to the distal gyri of the ascending colon ventrally (Fig. 4). This result was also described in pampas deer by Perez *et al.* (2008) who reported that the whole intestine was enveloped by greater omentum except the descending duodenum. As well as Klaus-Dieter and Robert, (2003) who observed in bovine that the superficial wall of the greater omentum passed in parallel to the descending duodenum and ventrally to it.

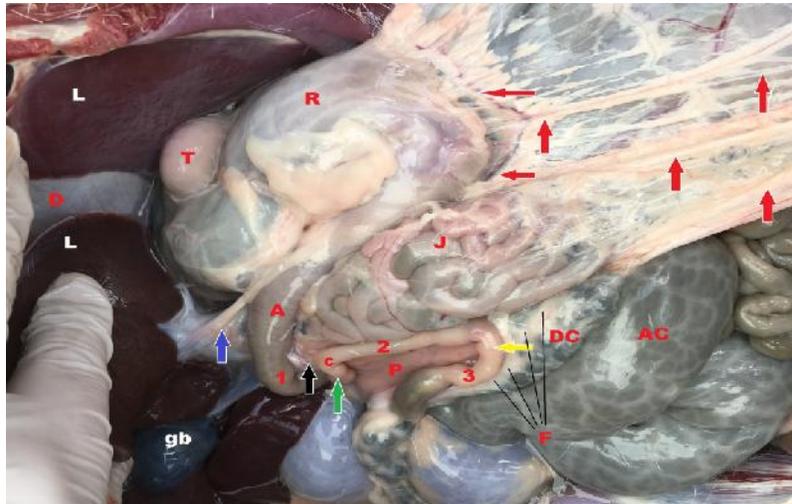


FIGURE 4: Photograph shows different parts of small and large intestine of the indigenous Gazelle. It showed Rumen (R), reticulum (T), Abomasum (A), pyloric area of abomasum (1), jejunum (J), liver (L), gall bladder (gb), diaphragm (D), descending colon (DC), ascending colon (AC), hepatoduodenal ligament (black arrow), and gastrohepatic ligament (blue arrow) and duodenocolic fold (F). The figure showed different part of duodenum: cranial part (green arrow), cranial flexure (C), descending part (2), caudal flexure (yellow arrow) and ascending part (3).

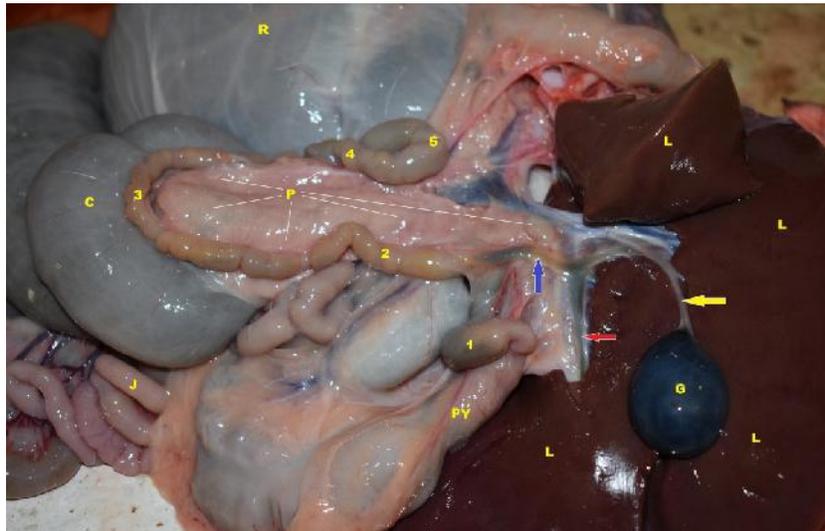


FIGURE 5: Photograph shows different parts of duodenum and relative organs of the indigenous Gazelle. It showed cranial part of duodenum (1), descending duodenum (2), caudal flexure (3), ascending duodenum (4), duodeno-jejunal flexure (5), pancreas between limbs of duodenum (P), liver (L), gall bladder (G), pyloric part of abomasum (PY), jejunum (J), Rumen (R), ascending colon, cystic duct (yellow arrow), hepatic duct (red arrow) and common bile duct (blue arrow).

Macroscopically, the present finding showed that the duodenum was formed the first loop of small intestine, like incomplete U-shape, pink in color; arise immediately

after pyloric area of abomasum and extend caudally right to the stomach then extend somewhat cranially for short distance that aid to hold the pancreas between it

descending and ascending U- shaped limbs. It began firstly with cranial part (broadened bit), that run parallel with a descending portion of the large intestine, then advanced caudo-medially to the caudate lobe and dorsally to the porta of the liver to took after by the cranial duodenal flexure and the descend segment of the duodenum that ended at the caudal flexure (Fig. 4 and 5). These finding was parallel to the observations in pampas deer (Perez *et al.*, 2008), in bovine (Klaus-Dieter and Robert, 2003) and in free living axis deer (Perez *et al.*, 2014) who mentioned that duodenum was connect ventro-caudally with the pylorus and also record that the duodenum take different position from the ventral end of the 9th to that of the 12th intercostal space, it run dorsally to the porta of the liver and curved caudally as a cranial flexure then continued as

a descended segment of the duodenum accompanied with the right lobe of the pancreas.

A point of demarcation among duodenum and jejunum segments of the small intestine especially observed when the distal colon passes over the duodeno-jejunal flexure, and at the jejunal arches of blood vessels in the mesentery that suspended the jejunum (Fig. 5 and 6). This finding also showed in different domestic ruminant as in bovines, ovines and caprine (Barone, 1997, Smith, 1984, Klaus-Dieter and Robert, 2003), Pampas Deer (Perez *et al.*, 2008), in the Brown Brocket deer (Pérez, and Vazquez, 2012) and in Free-living Axis Deer (Perez *et al.*, 2014) whom mentioned that the point of demarcation between duodenum and jejunum was differentiated at the duodeno-jejunal flexure.

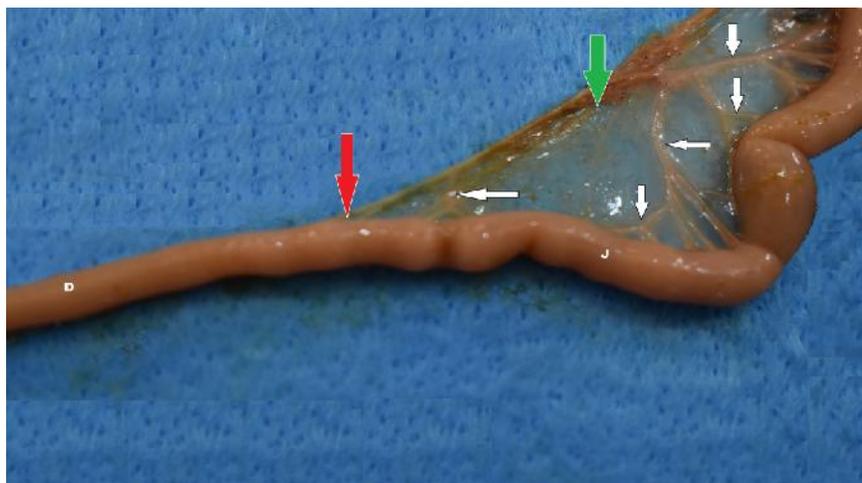


FIGURE 6: Photograph showed: the transitional area between the duodenum and jejunum (red arrow), duodenum (D), jejunum (J), jejunal blood vessels (white arrow) and mesojejunum (green arrow).

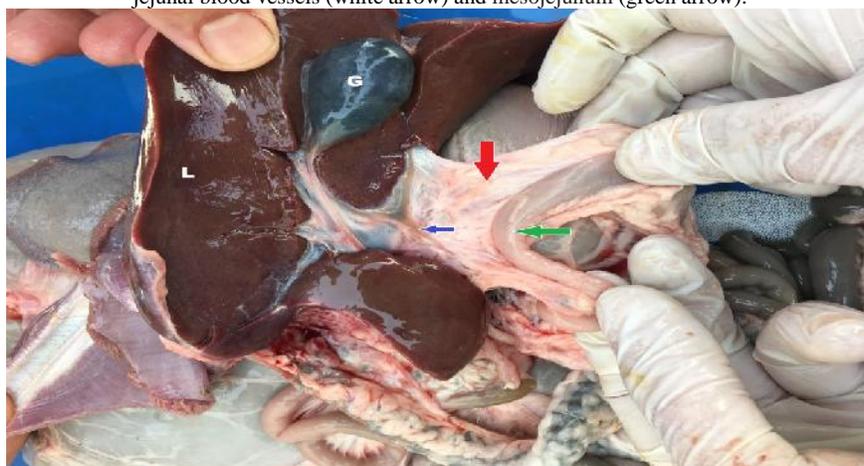


FIGURE 7: Photograph shows the hepatoduodenal ligament (part of lesser omentum). It showed duodenum (green arrow), hepatoduodenal ligament (red arrow), common bile duct (blue arrow), liver (L) and gall bladder (G).

Anatomical observation was revealed that the mesoduodenum suspended duodenal parts which comprised the body and right lobe of pancreas. The short mesoduodenum was holding the duodenum in its position. The cranial part of the duodenum was connected with the liver by the hepatoduodenal ligament. Within the hepatoduodenal ligament passes the common bile duct

(ductus choledochus) from the liver to the duodenum (Fig. 2, 4, 5 and 7). In another aspect the ascending duodenum was settled by the duodenocolic fold to the descending colon (Fig. 4). The same observations were also showed in different animals as in bovines (Klaus-Dieter and Robert, 2003), in Pampas Deer (Perez *et al.*, 2008) in the Brown Brocket deer (Pérez, and Vazquez, 2012) and in Free-

living Axis Deer (Perez, *et al.*, 2014) whom was mentioned descending colon was observed dorsally to the ascending duodenum and adherent to it by the duodenocolic fold, in another hand the hepatoduodenal ligament was attached the porta of liver to the cranial flexure of the duodenum as free border from lesser omentum.

The present findings revealed that the jejunum in the indigenous Gazelle was the longest most mobile tubular organs, dark pink to gray in color part, situated between the duodenum and ileum (Fig. 3 and 4). The jejunum was began at the final segment of duodenum in which that located ventrally to the second lumbar vertebra near the base of the common mesentery at the median plane. Then the jejunum was advanced and framed many loops in the left mid-abdominal area and dorsal to the caecum to end at the ileum. The jejunal coils situated mainly closer to the ascending colon, behind the rumen against the left flank. It runs as many loops caudoventrally to reach the ileum

without an unmistakable limit between them, the variance between the jejunum and ileum was remarked by the ileocaecal fold attached (Fig. 2, 3, and 4). The above results were agreed with (Klaus-Dieter and Robert, 2003) in bovines, (Perez *et al.*, 2008) in Pampas Deer, (Pérez, and Vazquez, 2012) in the Brown Brocket deer and (Perez, *et al.*, 2014) in Free-living Axis Deer,

That mentioned the jejunum in above animals were run in parallel the coiled ascending colon like a wreath, it runs through many loops caudoventrally to the ileum without a clear boundary between them.

A mesojejunum was upheld the jejunum to the abdominal roof which contained the jejunal vessels and jejunal arches between its mesentery sheets. The right surface of the mesojejunum was partly attached to the ascending colon, especially the centrifugal part (Fig. 3, 4 and 6). This result was in accordance with that obtained by (Klaus-Dieter and Robert, 2003) and Perez *et al.*, 2008) in bovine and Pampas Deer respectively.

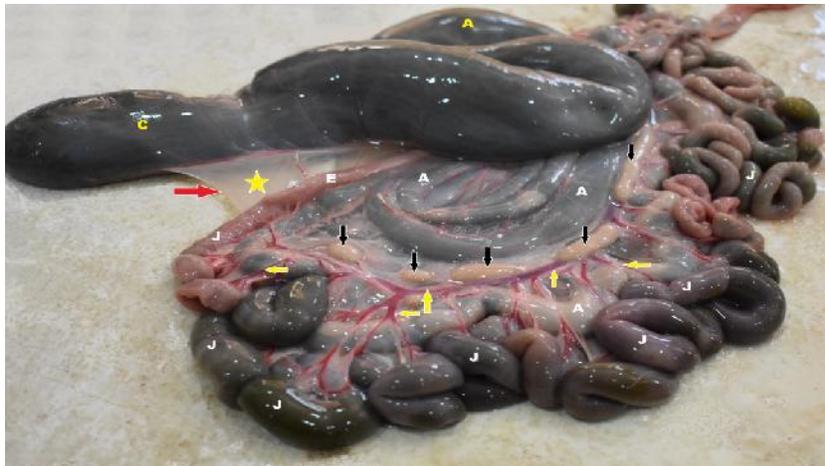


FIGURE 8: Photograph in different parts of small intestine. It showed ileum (E), jejunum (J), cecum (C), ascending colon (A), ileocaecal fold (red arrow), jejunal arteries (yellow arrow), jejunal lymph nodes (black arrow) and mesoileum (yellow star).

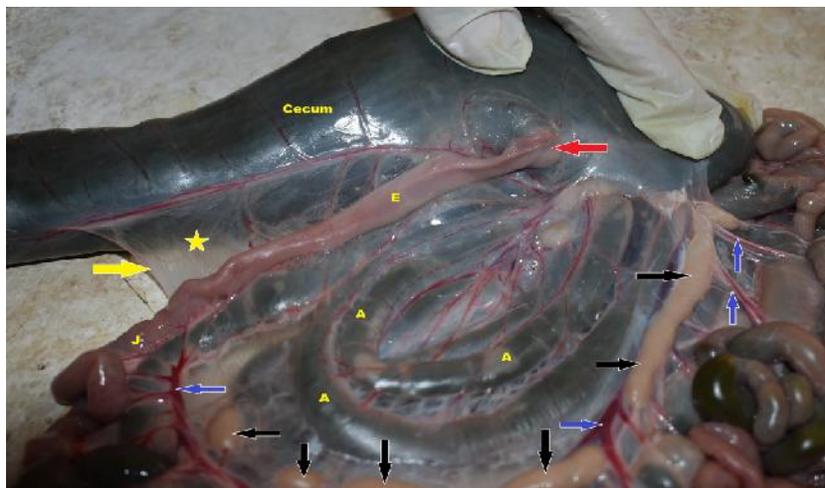


FIGURE 9: Photograph shows the junction of ileum with Jejunum (J) in side and cecum in other side at the ileal orifice (red arrow). The figure showed ascending colon (A), ileocaecal fold (yellow arrow), mesoileum (yellow star), jejunal arteries (blue arrow) and jejunal lymph nodes (black arrow).

Ileum was short tubular terminal part of small intestine; appeared dark pink to gray in color. It began at the final segment of the jejunum lies on and attached to floor of

abdomen and passed to the right in suitable ventrally to the fifth lumbar vertebra then curved caudally to be entered the caecum (Fig. 3). The ileum observed as a straight

segment of the small intestine near the caecum and attached to it by the ileocecal fold, eventually, it open into the caecum by the ileal orifice at of the 4th lumbar vertebra. On another hand, a present anatomical study revealed that there were no demarcation lines that separate anatomically between jejunum and ileum instead of the border of ileocecal fold (Fig. 3, 8 and 9).

The mesojejunum was continuous with mesoileum and had the form of a large fan hanging from the abdominal roof with the convoluted jejunum and ileum that situated in its free distal (Fig. 3, 8 and 9). Similar to that recorded by (Barone, 1997, Smith, 1984, Klaus-Dieter and Robert, 2003) in bovines, ovines and caprine, (Perez *et al.*, 2008) in Pampas Deer, (Perez *et al.*, 2009) in giraffe, (Pérez, and Vazquez, 2012) in the Brown Brocket deer and (Perez, *et al.*, 2014) in Free-living Axis Deer.

Gross Measurements

The morphological measurements in the indigenous Gazelle revealed in (Fig. 1) showed that the small intestine measures about 9 times the length of the animal. This result was incompatible with (Barone, 1996; Rush, 2009; Dyce and Wensing, 2010) whom measured that the length of the intestine to be five times relative to the animal

length in carnivores, ten times the animal length in the horse and 20 to 25 times the animal length in ruminants.

The recent gross morphometric estimations of lengths and relative lengths that exposed in different segment of the small intestine were well outlined in tables (1). It indicated most significant increase of length in the jejunum compared to duodenum and ileum. The date of weights data of the small intestine segments were introduced in table (2), that explain the significant elevated weight and relative weight recorded to the jejunum than those of duodenum and ileum, as well as the weight of each part of small intestine relative to the whole small intestine weight. Similar measurement was recorded by (Barone, 1997, Smith, 1984, Klaus-Dieter and Robert, 2003) in bovines, ovines and caprine, (Perez *et al.*, 2008) in Pampas Deer, (Perez *et al.*, 2009) in giraffe, (Pérez, and Vazquez, 2012) in the Brown Brocket deer and (Perez, *et al.*, 2014) in Free-living Axis Deer. The remarkable significant variation of length and weight of each part small intestine in the indigenous Gazelle may be due to the high contents of fibers in their diet which need more time and largest area to digest.

TABLE 1: Lengths and relative lengths of small intestine parts (cm): Duodenum, Jejunum and Ileum. The numbers represent the mean \pm standard error.

Segment of small Intestine	Length/ Mean \pm SE	Relative length
Duodenum	51 \pm 4.93	6.39%
Jejunum	725.80 \pm 21.67	90.88%
Ileum	21.80 \pm 0.72	2.73%
Total small intestine length	798.6 \pm 23.40	

TABLE 2: Weights and relative weights of small intestine parts (Gram): Duodenum, Jejunum and Ileum. The numbers represent the mean \pm standard error.

Segment of small Intestine	weight/ Mean \pm SE	Relative weight
Duodenum	14.50 \pm 0.45	7.49%
Jejunum	169.50 \pm 2.10	87.60%
Ileum	9.50 \pm 0.45	4.91%
Total small intestine weight	193.5 \pm 2.72	

CONCLUSION

The experimental result on morphological observation was concluding that the small intestine in the indigenous gazelle situated in the most right caudal area of abdominal cavity which starting from the stomach and ended at the caecum. It composed of three segments (duodenum, jejunum and ileum) the significant increase of length and weight was in the jejunum compared to duodenum and ileum.

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